CLAIMS

What is claimed is:

1.   A method for generating a trap pixel of a trap area surrounding one or more trapping edges of an image, the method comprising:

5   for each trapping edge in the image, for each pixel within a predefined area around the trapping edge,

comparing the distance of said each pixel from the trapping edge according to a distance measure with a provided measure indicative of the distance of the pixel from any edge of the image to determine if said each pixel is closer

10   to the trapping edge than to another edge; and

if said pixel is closer to said edge than to any edge, setting the pixel as a trap pixel of the trap area, including setting a trap color for the trap pixel.

2.   A method as described in claim 1, further comprising:

determining the trapping edges of the image by applying a trapping

15   criterion to a neighborhood of each edge of the image.

3.   A method as described in claim 2, further comprising:

determining the edges of the image.

4.   A method as described in claim 2, wherein at least some of the edges of the image are provided so that edge detection is not required for the provided edges.

20   5.   A method as described in claim 1, wherein the provided measure is contained in a pixel buffer indicating for any pixel how close that pixel is to any edge, and wherein the distance comparing includes comparing the distance measure of said each pixel to the value in the pixel buffer,

the method further comprising ,

25   if said pixel is closer to said edge than to any edge as indicated by the comparison, replacing the value in the pixel buffer with the distance measure

of said each pixel from the trapping edge, such that the pixel buffer converges to indicating the closest distance of any pixel to any edge,

any traps generated around the trapping edges thereby being centerline traps.

6. A method as described in claim 1, wherein the trap color is user-provided.

7. A method as described in claim 1, wherein the trap color is determined according to a trapping criterion applied to a neighborhood of the trapping edge.

8. A method as described in claim 7, wherein the trapping criterion compares the lightness of the pixel to the lightness in the neighborhood.

9. A method as described in claim 1,

wherein the distance of a pixel from an edge point according to the distance measure defines a point distance function centered on the edge point, the maximum extent of the point distance function from the center defining a trapping distance,

wherein the point distance function is pre-calculated, and

wherein the distance comparing includes determining the distance of said each pixel from the trapping edge using the point distance function.

10. A method as described in claim 1,

wherein the distance comparing includes determining the distance of said each pixel from the trapping edge by calculation on the fly.

11. A method as described in claim 1, wherein the extent of the predefined area around a trapping edge point defines a trapping distance, and wherein the trapping distance from any point on an edge varies as a function of direction from the point on the edge.

12. A method as described in claim 1, wherein the trap color of any trap pixel is modulated by a modulation factor, the modulation factor being a function of the distance from the trapping edge.

13. A method as described in claim 1, wherein at least some of the edges are defined by an edge line object having a geometric description, and wherein said comparing

step includes determining the distance of said pixel from an edge using the geometric description of the edge line object for any edge defined by an edge line object.

14.   A method as described in claim 1,

wherein at least some of the trapping edges are defined by a set of edge pixels, the method further comprising carrying out the steps of comparing and conditional trap pixel setting for each edge pixel of any edge defined by a set of edge pixels,

such that the method comprises,

for each edge defined by edge pixels, for each pixel within a predefined area around the edge pixel,

comparing the distance of said each pixel from the edge pixel according to the distance measure with a provided measure indicative of the distance of the pixel from any edge of the image to determine if said each pixel is closer to the edge than pixel to another edge; and

if said pixel is closer to said edge pixel than to any edge, setting the pixel as a trap pixel of the trap area, including setting a trap color for the trap pixel.

15.   A method as described in claim 14, wherein the comparing compares the distance of said each pixel to the value stored in a pixel buffer containing at each pixel location the distance measure of that pixel location to the nearest so-far encountered edge pixel of the image, and setting the trap pixel in said conditional trap pixel setting step further includes replaces the value stored in the pixel buffer with the distance measure for the pixel,

the method thereby generating a centerline traps around the edge pixels.

16.   A method as described in claim 15, wherein the pixel buffer is in a z-buffer such that the comparison step and conditional replacement step are automatically carried out.

17.   A method as described in claim 15, further comprising:

determining the edge pixels of the trapping edges by applying a trapping criterion to pixels of one or more edges of the image.

18.   A method as described in claim 15, further comprising:

determining the edge pixels of the one or more edges by edge detecting the image.

19.   A method as described in claim 18, wherein the edge detecting includes edge enhancing the image and thresholding the results of enhancing.

20.   A method as described in claim 15, wherein the setting of a trap pixel sets the pixels of a trapping image, the method further comprising:

combining the image with the trapping image to form a trapped image.

21.   A method as described in claim 14, wherein the comparing compares the distance of said each pixel to the values stored in a subset of a plurality of pixel buffers, each containing at each pixel location the distance measure of that pixel location to the nearest so-far encountered edge pixel of the image, each pixel buffer having an associated trapping image, and

wherein setting the trap pixel in said conditional trap pixel setting step further includes replaces the value stored in each pixel buffer of the subset with the distance measure for the pixel, and setting a pixel of each associated trapping image associated with each pixel buffer of the subset.

22.   A method as described in claim 21, wherein the image has a set of color components,

wherein the at least some of the trapping edges defined by edge pixels are each an edge in one of the image color components, and

wherein the plurality of pixel buffers includes a pixel buffer for each color component, the pixel buffer of a color component containing at each pixel location the distance measure of that pixel location to the nearest so-far encountered edge pixel of the image in that color component, such that the comparing of the distance to an edge pixel of a color component compares the distance of said each pixel to the value stored in the pixel buffer of that color component containing at each pixel location the distance measure of that pixel location to the nearest so-far encountered edge pixel of that color component,

such that each color component of the image has an associated trapping image.

23. A method as described in claim 21, wherein the at least some of the trapping edges defined by edge pixels each have an associated trap color, and

wherein the plurality of pixel buffers includes a pixel buffer for each trap color component, the pixel buffer of a color component containing at each pixel location the distance measure of that pixel location to the nearest so-far encountered edge pixel of the image having that associated trap color, such that the comparing of the distance to an edge pixel associated with a trap color compares the distance of said each pixel to the value stored in the pixel buffer of that trap color containing at each pixel location the distance measure of that pixel location to the nearest so-far encountered edge pixel of that trap color,

such that each trap color has an associated trapping image.

24. A method as described in claim 20, wherein at each trapping edge a keepaway may be generated according to a keepaway criterion, the keepaway describing the amount to be subtracted from the original image, and

wherein the setting of a trap pixel also sets the pixels of a keepaway image in the case that a keepaway is generated.

25. A carrier medium carrying computer readable code segments to instruct one or more processors of a processing system to generate a trap pixel of a trap area surrounding one or more trapping edges of an image, the medium comprising:

one or more code segments to instruct the one or more processors, for each trapping edge in the image, for each pixel within a predefined area around the edge,

to compare the distance of said each pixel from the trapping edge according to a distance measure to determine if said each pixel is closer to the trapping edge than to another edge by comparing the distance measure of said each pixel with a provided measure indicative of the distance of the pixel from any edge of the image; and

if said pixel is closer to said edge than to any edge, to set the pixel as a trap pixel of the trap area, including setting a trap color for the trap pixel.

26.   A carrier medium as described in claim 25, further comprising:

>   one or more code segments to instruct the one or more processors to determine the trapping edges of the image by applying a trapping criterion to a neighborhood of each edge of the image.

27.   A carrier medium as described in claim 26, further comprising:

>   one or more code segments to instruct the one or more processors to determine the edges of the image.

28.   A carrier medium as described in claim 26, wherein at least some of the edges of the image are provided so that edge detection is not required for the provided edges.

29.   A carrier medium as described in claim 25, wherein the provided measure is contained in a pixel buffer indicating for any pixel how close that pixel is to any edge, and wherein the distance comparing includes comparing the distance measure of said each pixel to the value in the pixel buffer,

the carrier medium further comprising ,

>   one or more code segments to instruct the one or more processors to replace, if said pixel is closer to said edge than to any edge as indicated by the comparison, the value in the pixel buffer with the distance measure of said each pixel from the trapping edge, such that the pixel buffer converges to indicating the closest distance of any pixel to any edge,

any traps generated around the trapping edges thereby being centerline traps.

30.   A carrier medium as described in claim 25, wherein the trap color is user-provided.

31.   A carrier medium as described in claim 25, wherein the trap color is determined according to a trapping criterion applied to a neighborhood of the trapping edge.

32.   A carrier medium as described in claim 31, wherein the trapping criterion compares the lightness of the pixel to the lightness in the neighborhood.

33.   A carrier medium as described in claim 25,

wherein the distance of a pixel from an edge point according to the distance measure defines a point distance function centered on the edge point, the maximum extent of the point distance function from the center defining a trapping distance,

wherein the point distance function is pre-calculated, and

5   wherein the distance comparing includes determining the distance of said each pixel from the trapping edge using the point distance function.

34.   A carrier medium as described in claim 25,

wherein the distance comparing includes determining the distance of said each pixel from the trapping edge by calculation on the fly.

10   35.   A carrier medium as described in claim 25, wherein the extent of the predefined area around a trapping edge point defines a trapping distance, and wherein the trapping distance from any point on an edge varies as a function of direction from the point on the edge.

36.   A carrier medium as described in claim 25, wherein the trap color of any trap pixel
15   is modulated by a modulation factor, the modulation factor being a function of the distance from the trapping edge.

37.   A carrier medium as described in claim 25, wherein at least some of the edges are defined by an edge line object having a geometric description, and wherein said comparing step includes determining the distance of said pixel from an edge using the
20   geometric description of the edge line object for any edge defined by an edge line object.

38.   A carrier medium as described in claim 25,

wherein at least some of the trapping edges are defined by a set of edge pixels, the method further comprising carrying out the steps of comparing and conditional trap
25   pixel setting for each edge pixel of any edge defined by a set of edge pixels,

such that the carrier medium comprises one or more code segments to instruct the one or more processors,

for each edge defined by edge pixels, for each pixel within a predefined area around the edge pixel,

to compare the distance of said each pixel from the edge pixel according to the distance measure with a provided measure indicative of the distance of the pixel from any edge of the image to determining if said each pixel is closer to the edge than pixel to another edge; and

if said pixel is closer to said edge pixel than to any edge, to set the pixel as a trap pixel of the trap area, including setting a trap color for the trap pixel.

39.   A carrier medium as described in claim 38, wherein the comparing compares the distance of said each pixel to the value stored in a pixel buffer containing at each pixel location the distance measure of that pixel location to the nearest so-far encountered edge pixel of the image, and setting the trap pixel in said conditional trap pixel setting further includes replaces the value stored in the pixel buffer with the distance measure for the pixel,

the method thereby generating a centerline traps around the edge pixels.

40.   A carrier medium as described in claim 39, wherein the pixel buffer is in a z-buffer such that the comparison step and conditional replacement step are automatically carried out.

41.   A carrier medium as described in claim 39, further comprising:

one or more code segments to instruct the one or more processors to determine the edge pixels of the trapping edges by applying a trapping criterion to pixels of one or more edges of the image.

42.   A carrier medium as described in claim 39, further comprising:

one or more code segments to instruct the one or more processors to determine the edge pixels of the one or more edges by edge detecting the image.

43.   A carrier medium as described in claim 42, wherein the edge detecting includes edge enhancing the image and thresholding the results of enhancing.

44.   A carrier medium as described in claim 39, wherein the setting of a trap pixel sets the pixels of a trapping image, the carrier medium further comprising:

> one or more code segments to instruct the one or more processors to combine the image with the trapping image to form a trapped image.

45.   A carrier medium as described in claim 38, wherein the comparing compares the distance of said each pixel to the values stored in a subset of a plurality of pixel buffers, each containing at each pixel location the distance measure of that pixel location to the nearest so-far encountered edge pixel of the image, each pixel buffer having an associated trapping image, and

wherein setting the trap pixel in said conditional trap pixel setting step further includes replaces the value stored in each pixel buffer of the subset with the distance measure for the pixel, and setting a pixel of each associated trapping image associated with each pixel buffer of the subset.

46.   A carrier medium as described in claim 45, wherein the image has a set of color components,

wherein the at least some of the trapping edges defined by edge pixels are each an edge in one of the image color components, and

wherein the plurality of pixel buffers includes a pixel buffer for each color component, the pixel buffer of a color component containing at each pixel location the distance measure of that pixel location to the nearest so-far encountered edge pixel of the image in that color component, such that the comparing of the distance to an edge pixel of a color component compares the distance of said each pixel to the value stored in the pixel buffer of that color component containing at each pixel location the distance measure of that pixel location to the nearest so-far encountered edge pixel of that color component,

such that each color component of the image has an associated trapping image.

47.   A carrier medium as described in claim 45, wherein the at least some of the trapping edges defined by edge pixels each have an associated trap color, and

wherein the plurality of pixel buffers includes a pixel buffer for each trap color component, the pixel buffer of a color component containing at each pixel location the distance measure of that pixel location to the nearest so-far encountered edge pixel of the image having that associated trap color, such that the comparing of the distance to an edge pixel associated with a trap color compares the distance of said each pixel to the value stored in the pixel buffer of that trap color containing at each pixel location the distance measure of that pixel location to the nearest so-far encountered edge pixel of that trap color,

such that each trap color has an associated trapping image.

48.   A carrier medium as described in claim 44, wherein at each trapping edge a keepaway may be generated according to a keepaway criterion, the keepaway describing the amount to be subtracted from the original image, and

wherein the setting of a trap pixel also sets the pixels of a keepaway image in the case that a keepaway is generated.

49.   A method for generating a trap area surrounding an point on an edge of an image, the trap area comprised of pixels having a color, the method comprising:

for each pixel in an area surrounding the edge point,

determining the distance of the pixel from the edge point by calculating a distance measure indicative of the distance;

comparing the calculated distance measure with a second distance measure for the pixel indicative of the distance of the pixel to another edge, the comparing to determine if the pixel is closer to the edge point than to another edge; and

if the pixel is closer to the edge point than to any other edge, setting the pixel as a trap pixel of a trap region having a color determined according to a trapping criterion applied to the neighborhood of the edge.

50.   A method as described in claim 49, wherein the step of setting the trap pixel further includes storing the distance of the pixel from the edge point, and wherein the

second measure is a stored measure indicative of the distance of the pixel from any other edge of the image.

51.   A method as described in claim 50, wherein said step of comparing compares the determined distance measure to the value stored in a pixel buffer containing at each pixel location the distance measure of that pixel location to the nearest edge of the image, and wherein said step of setting the trap pixel further replaces the value stored in the pixel buffer with the determined distance measure for the pixel,

the method thereby generating a centerline trap area around the edge point according to the trapping criterion.

52.   A method as described in claim 51, wherein the pixel buffer is in a z-buffer such that the comparison step is automatically carried out.

53.   A method as described in claim 49, wherein said step of comparing compares the determined distance measure to the value stored in a pixel buffer containing at each pixel location the distance measure of that pixel location to the nearest so-far encountered edge of the image, and wherein said step of setting the trap pixel further replaces the value stored in the pixel buffer with the determined distance measure for the pixel,

the method thereby generating a centerline trap area around the edge point according to the trapping criterion.

54.   A method as described in claim 53, wherein the pixel buffer is in a z-buffer such that the comparison step is automatically carried out.

55.   A method for trapping an image comprised of pixels at pixel locations, the method comprising:

providing the edges of the image;

determining the traps for the image; and

combining the traps for the image with the image to obtain a modified image,

said step of determining the traps for the image including, for each edge pixel of each edge provided in the edge providing step, determining if the edge pixel is to be

trapped according to a trapping criterion applied to the neighborhood of the edge pixel, and if the edge pixel is to be trapped, for each pixel in an area surrounding the edge pixel,

determining the distance of the pixel from the edge pixel by calculating a distance measure indicative of the distance;

comparing the calculated distance measure with a stored value indicative of the distance of the pixel from an edge of the image to determine if the pixel is closer to the edge pixel than to any other edge; and

if the pixel is closer to the edge pixel than to any other edge, setting the pixel as a trap pixel of a trap region with a color determined according to the trapping criterion.

56.   A method as described in claim 55, wherein said step of providing the edges of the image includes detecting the edges of the image.

57.   A method as described in claim 56, wherein detecting edges of the image includes:

enhancing the edges of the image to generate an edge enhanced image, and

determining if a pixel is an edge pixel by comparing a pixel of the edge enhanced image to a threshold.

58.   A method as described in claim 55, wherein said step of comparing compares the determined distance measure to the value stored in a pixel buffer containing at each pixel location the distance measure of that pixel location to the nearest so-far encountered edge of the image, and wherein said step of setting the trap pixel further replaces the value stored in the pixel buffer with the determined distance measure for the pixel.

59.   A method as described in claim 58, wherein the pixel buffer is in a z-buffer such that the comparison step is automatically carried out.

60.   A method for generating one or more trap areas surrounding edges in color
components of an image, each trap area comprised of pixels having a color, the
method comprising:

providing the edges of the image in each color component;

5   providing a buffer of values, one value per pixel location in the image, with
all values initially set to an initial value, the values indicative of distance
according to a distance measure, the initial value indicative of a distance
larger than a pre-determined distance;

selecting an edge in a color component starting with a first edge and
10   repeating for each selected edge:

selecting an edge pixel in the selected edge starting with a first edge
pixel and repeating for each selected edge pixel:

selecting a pixel in an area surrounding the selected edge
pixel, starting with a first selected pixel, the surrounding area
15   defined by a pre-selected pattern around the first edge pixel,
and repeating for each selected pixel;

determining the distance of the selected pixel from the
selected edge pixel by calculating a distance measure
indicative of the distance;

20   comparing the calculated distance measure with the
corresponding value in the buffer to determine if the selected
pixel is closer to the selected edge pixel than to any other edge;
and

if the comparison step indicates that the selected pixel is
25   closer to the selected edge pixel than to any other edge, setting
the selected pixel as a trap pixel of a trap region around the
selected edge pixel, and replacing the value stored in the buffer
with the determined distance measure for the pixel, the trap
pixel setting including setting a trap color for the set trap pixel,

until each pixel in the area surrounding each edge pixel of each edge has been selected.

61. A method as described in claim 60, wherein the color of the trap pixel set in the trap pixel setting step is determined according to a trapping criterion applied to the neighborhood of the selected edge pixel.

62. A method as described in claim 60, wherein the distance measure is an inverse measure with the minimum value of the measure being zero, and wherein the initial value is zero.

63. An apparatus to generate a trap pixel of a trap area surrounding one or more trapping edges of an image, the apparatus comprising:

for each trapping edge in the image, for each pixel within a predefined area around the edge,

distance comparing means to compare the distance of said each pixel from the trapping edge according to a distance measure with a provided measure indicative of the distance of the pixel from any edge of the image to determine if said each pixel is closer to the trapping edge than to another edge; and

trap pixel setting means coupled to the comparing means to set the pixel as a trap pixel of the trap area if said pixel is closer to said edge than to any edge, the setting including setting a trap color for the trap pixel.

64. An apparatus as described in claim 63, further comprising:

trapping-edge-determining means coupled to the comparing means to determine the edges of the image by applying a trapping criterion to a neighborhood of each edge of the image.

65. An apparatus as described in claim 64, further comprising:

edge determining means to determine the edges of the image.

66. An apparatus as described in claim 63, further comprising a memory coupled to the comparing means, the memory storing a pixel buffer containing the provided measure, the pixel buffer indicating for any pixel how close that pixel is to any edge,

wherein the distance comparing includes comparing the distance measure of said each pixel to the value in the pixel buffer,

the apparatus further comprising replacement means coupled to said memory and to said distance comparing means, the replacement means to replace the value in the

5   pixel buffer with the distance measure of said each pixel from the trapping edge if said pixel is closer to said edge than to any edge as indicated by the comparison, such that the pixel buffer converges to indicating the closest distance of any pixel to any edge,

any traps generated around the trapping edges thereby being centerline traps.

10   67.   An apparatus as described in claim 63, further including means to accept the trap color from a user.

      68.   An apparatus as described in claim 63, further including trap-color determining means coupled to said trap setting means to determine the trap color according to a trapping criterion applied to a neighborhood of the trapping edge.

15   69.   An apparatus as described in claim 63,

wherein the distance of a pixel from an edge point according to the distance measure defines a point distance function centered on the edge point, the maximum extent of the point distance function from the center defining a trapping distance,

wherein the point distance function is pre-calculated, and

20   wherein the distance comparing means uses the point distance function to determine the distance of said each pixel from the trapping edge.

      70.   An apparatus as described in claim 63,

wherein the distance comparing means determines the distance of said each pixel from the trapping edge by calculation on the fly.

25   71.   An apparatus as described in claim 63, wherein the trap color of any trap pixel is modulated by a modulation factor, the modulation factor being a function of the distance from the trapping edge.

      72.   An apparatus as described in claim 63,

wherein at least some of the trapping edges are defined by a set of edge pixels, wherein the distance comparing means and conditional trap pixel setting means carry out the distance comparing and conditional trap pixel setting for each edge pixel of any edge defined by a set of edge pixels.

5   73.   An apparatus as described in claim 72, further comprising a memory coupled to said distance comparing means and conditional trap pixel setting means, wherein the distance comparing means compares the distance of said each pixel to the value stored in a pixel buffer stored in said memory, the pixel buffer containing at each pixel location the distance measure of that pixel location to the nearest so-far

10   encountered edge pixel of the image, and wherein the conditional trap pixel setting means includes replacement means to replace the value stored in the pixel buffer with the distance measure for the pixel in the case that said pixel is closer to said edge pixel than to any edge pixel as indicated by the comparison,

the apparatus thereby generating a centerline traps around the edge pixels.

15   74.   An apparatus as described in claim 73, wherein the memory is organized a z-buffer that includes the distance comparing means and conditional replacement means.

75.   An apparatus as described in claim 73, further comprising:

trapping edge determining means to determine the edge pixels of the trapping edges by applying a trapping criterion to pixels of one or more edges of the

20   image.

76.   An apparatus as described in claim 73, further comprising:

an edge detector to determine the edge pixels of the one or more edges by edge detecting the image.

77.   An apparatus as described in claim 73, further comprising:

25   a second memory coupled to the trap pixel setting means, the second memory to store a trapping image; and

an image combiner coupled to the second memory,

wherein the trap pixel setting means sets the pixels of the trapping image, and wherein the image combiner is to combine the trapping image with the image.

78.   An apparatus to trapping an image comprised of pixels at pixel locations, the apparatus comprising:

5   a trapper accepting edges of the image as input to determine the traps for the image; and

a combiner coupled to the trapper and accepting the image and the traps, the combiner to combine the traps for the image with the image to form a modified image,

10   said trapper including:

a memory,

trap decision means to determine for each edge pixel of each edge if the edge pixel is to be trapped according to a trapping criterion applied to a neighborhood of the edge pixel,

15   distance comparing means coupled to said memory and to said trap decision means to compare, for each edge pixel to be trapped, for each pixel in an area surrounding the to-be-trapped edge pixel, the distance of the pixel from the edge pixel with a value stored in said memory indicative of the distance of the pixel from an edge of the image to determine if the pixel is

20   closer to the edge pixel than to any other edge, and

trap setting means to set the pixel as a trap pixel of a trap region with a color determined according to the trapping criterion if the pixel is closer to the edge pixel than to any other edge.

79.   An apparatus as described in claim 78, further comprising an edge detector

25   coupled to said trapper and accepting the image as input.